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**Wiltse et al.**

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(54) **HYBRID HYDRAULIC GAS PUMP SYSTEM**

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| ***E21B 47/047*** | (2012.01) |
| ***E21B 34/08*** | (2006.01) |
| ***E21B 34/10*** | (2006.01) |
| ***E21B 47/06*** | (2012.01) |
| ***E21B 47/07*** | (2012.01) |

(52) **U.S. Cl.**

CPC ............ ***E21B 43/129*** (2013.01); ***E21B 34/08*** (2013.01); ***E21B 34/10*** (2013.01); ***E21B 43/122*** (2013.01); ***E21B 43/123*** (2013.01); ***E21B 47/047*** (2020.05); *E21B 47/06* (2013.01); *E21B 47/07* (2020.05); *E21B 2200/04* (2020.05)

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CPC ...... E21B 43/129; E21B 34/10; E21B 43/122; E21B 43/123; E21B 34/08; E21B 47/047; E21B 2200/04; E21B 47/06; E21B 47/07

See application file for complete search history.

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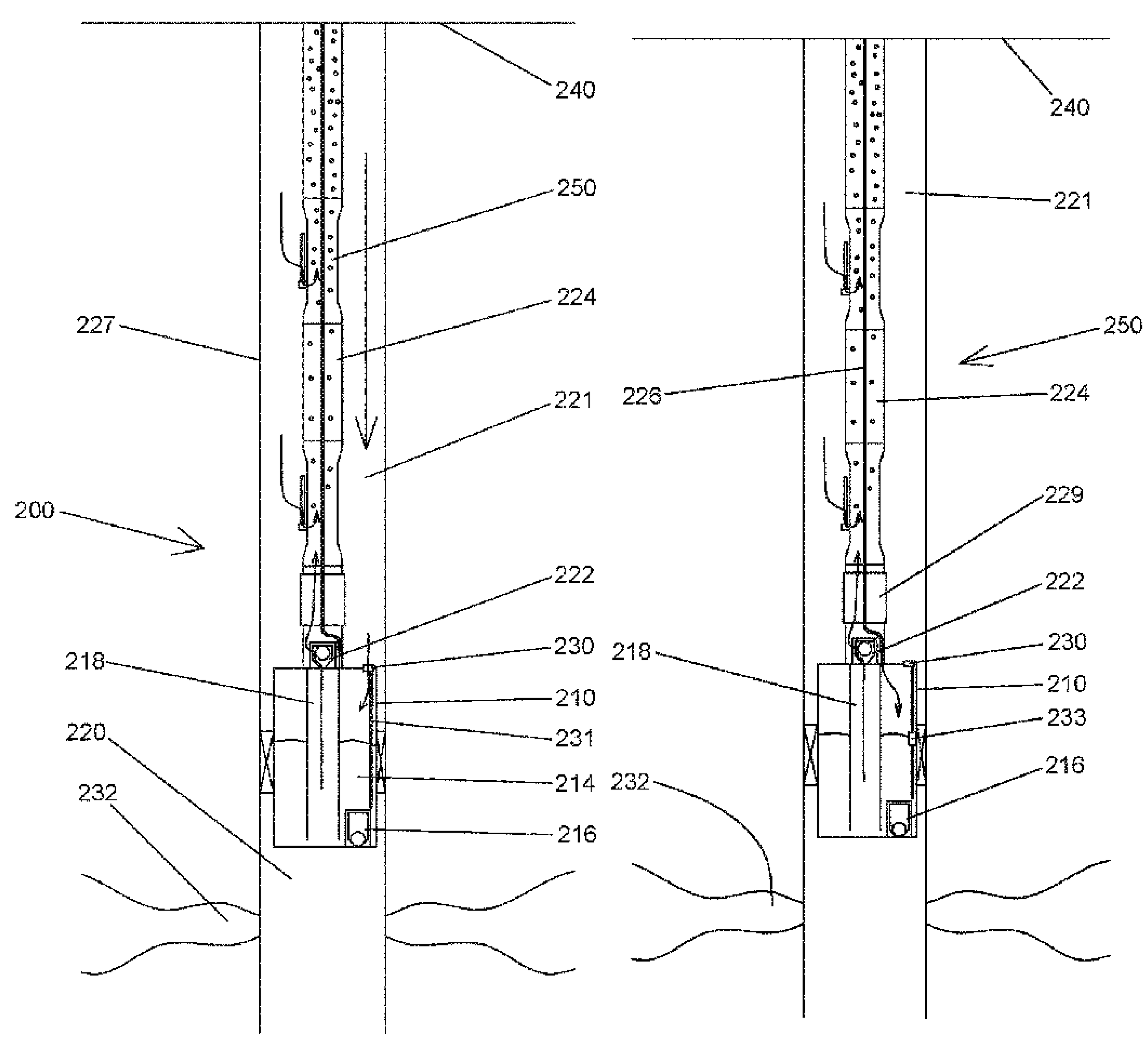
(57) **ABSTRACT**

A hybrid hydraulic gas pump system includes a hydraulic gas pump installed on the lower end of a production tubular where the production tubular incorporates a gas lift system. The hydraulic gas pump may be operated using the same gas in the annular region as the gas lift system or may be operated using an independent supply line where the independent supply line is concentric with, or at least within, the production tubular. In some instances, the gas pump chamber may simply be an upper packer including a pickup tube, a check valve, and a pressurized gas supply line or other pressurized gas access mechanism along with a lower packer including a check valve. Each upper and lower check valve allows fluid to flow from below the packer to above the packer.

**8 Claims, 14 Drawing Sheets**



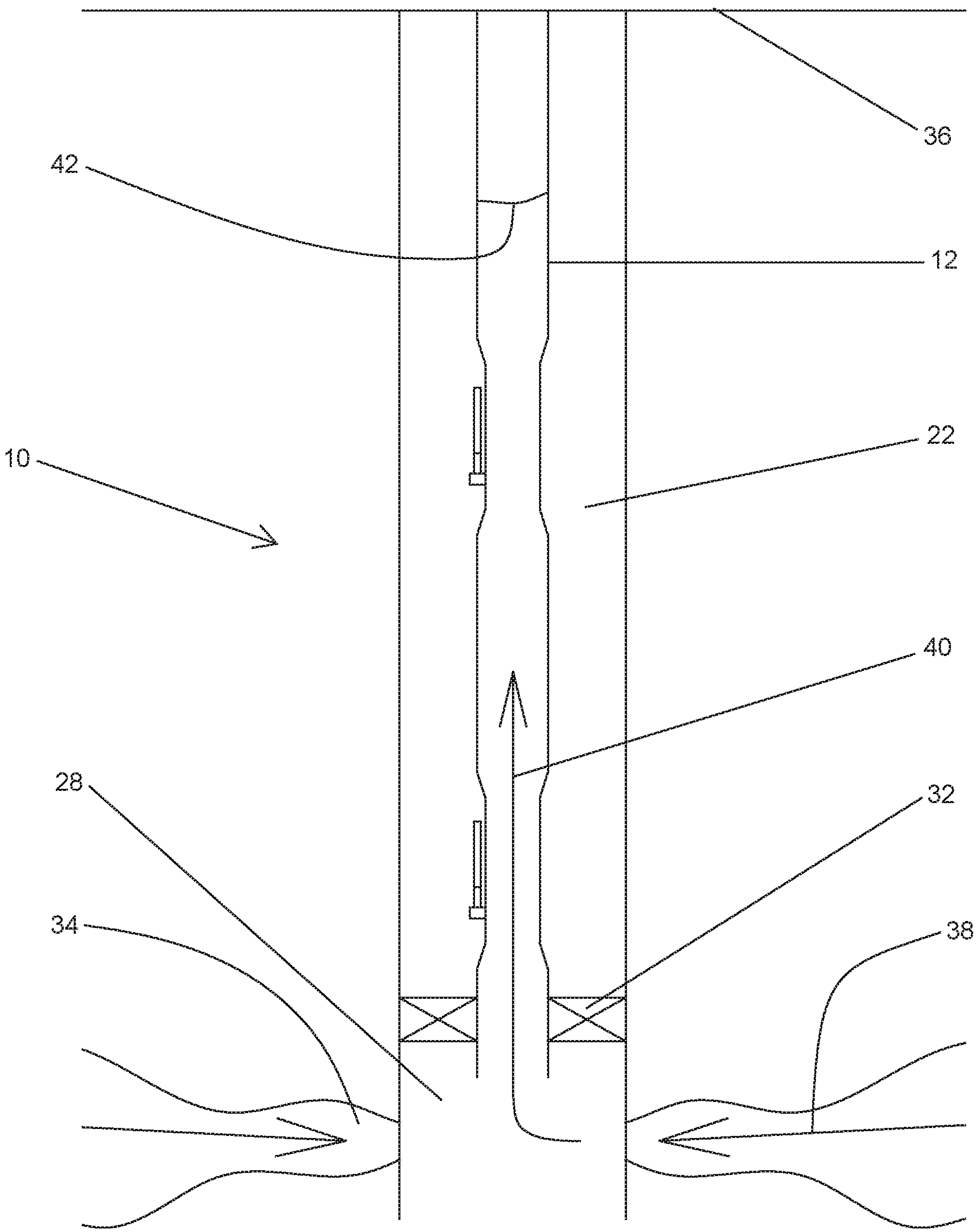



Figure 1

Prior Art

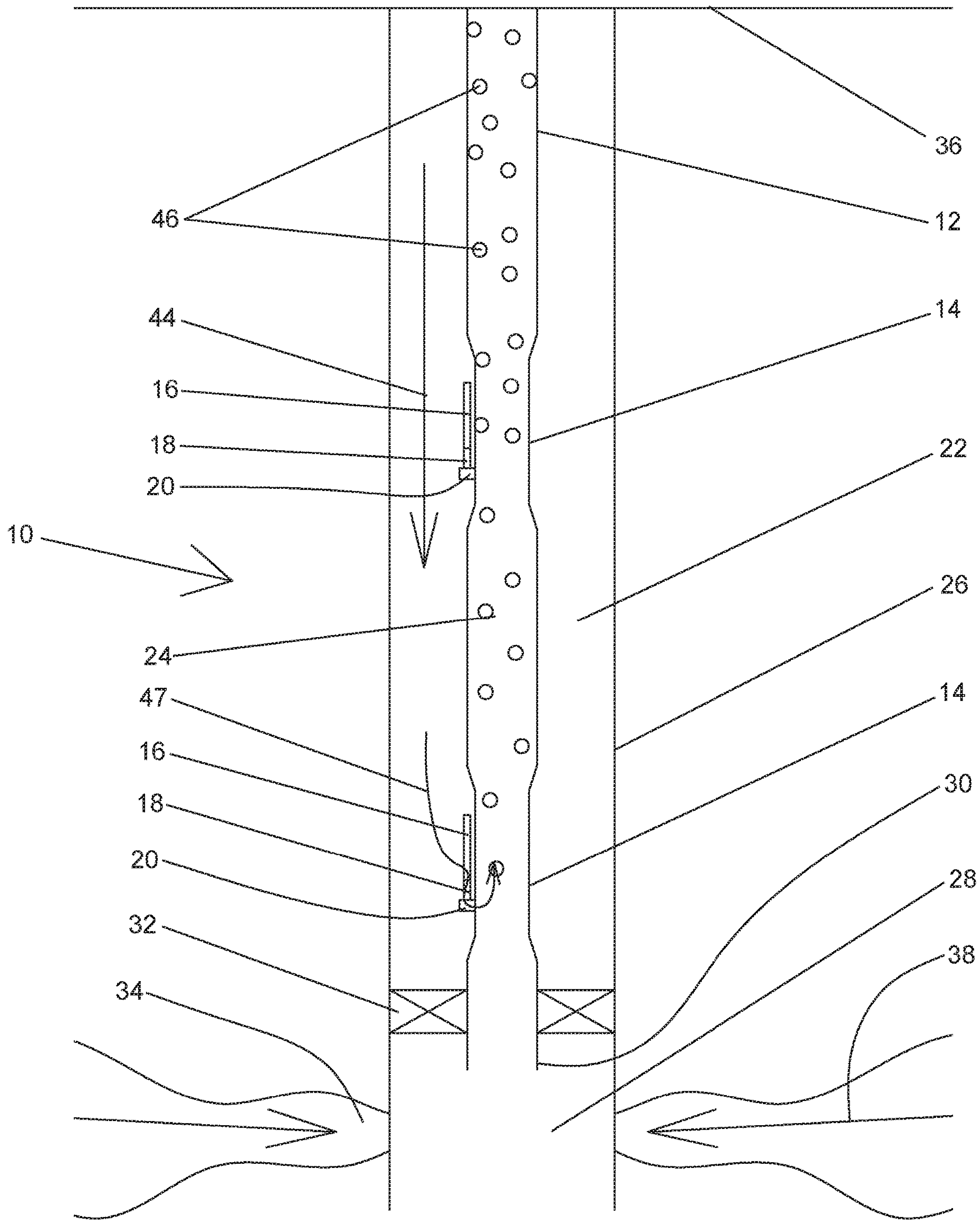



Figure 2

Prior Art

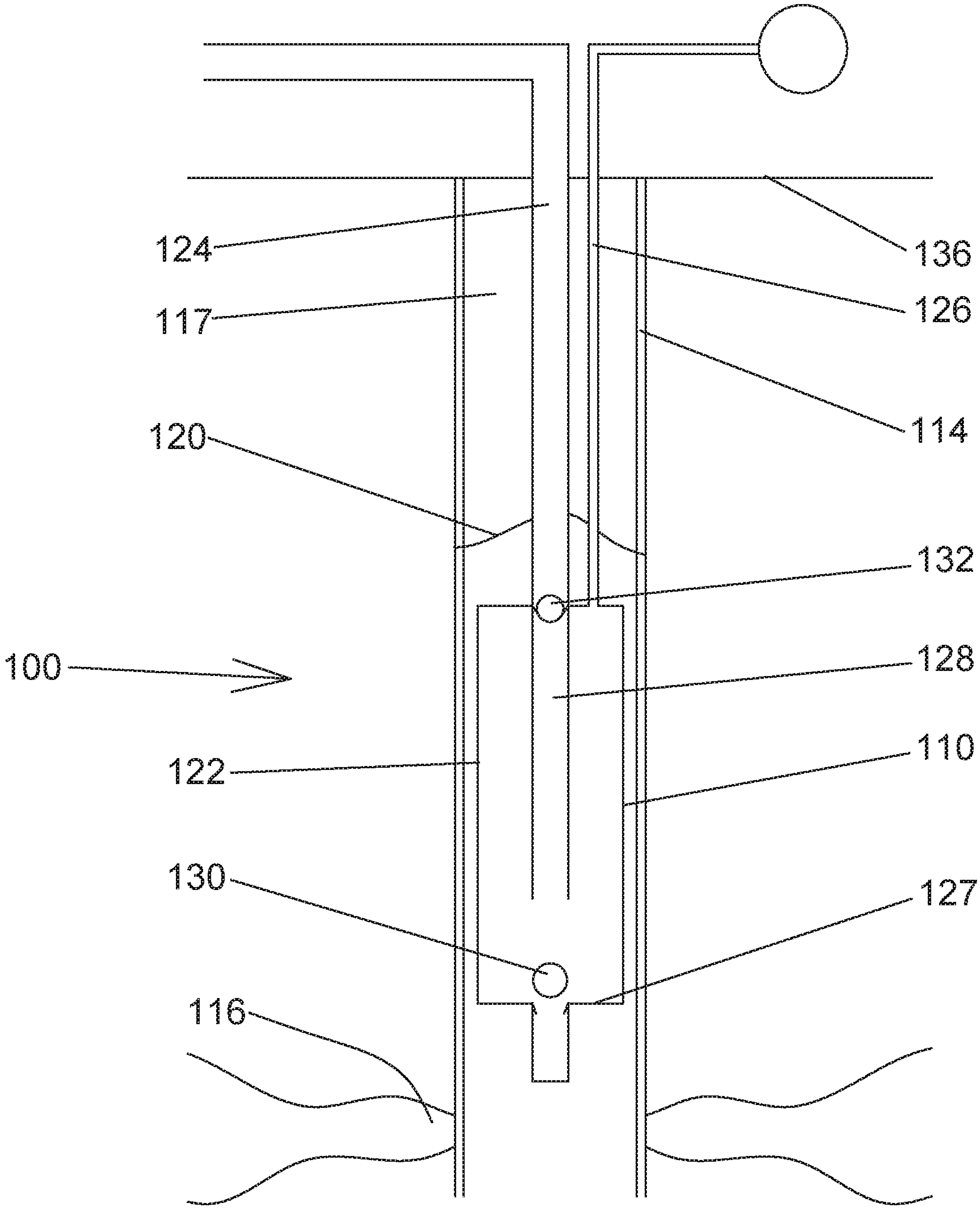



Figure 3

Prior Art

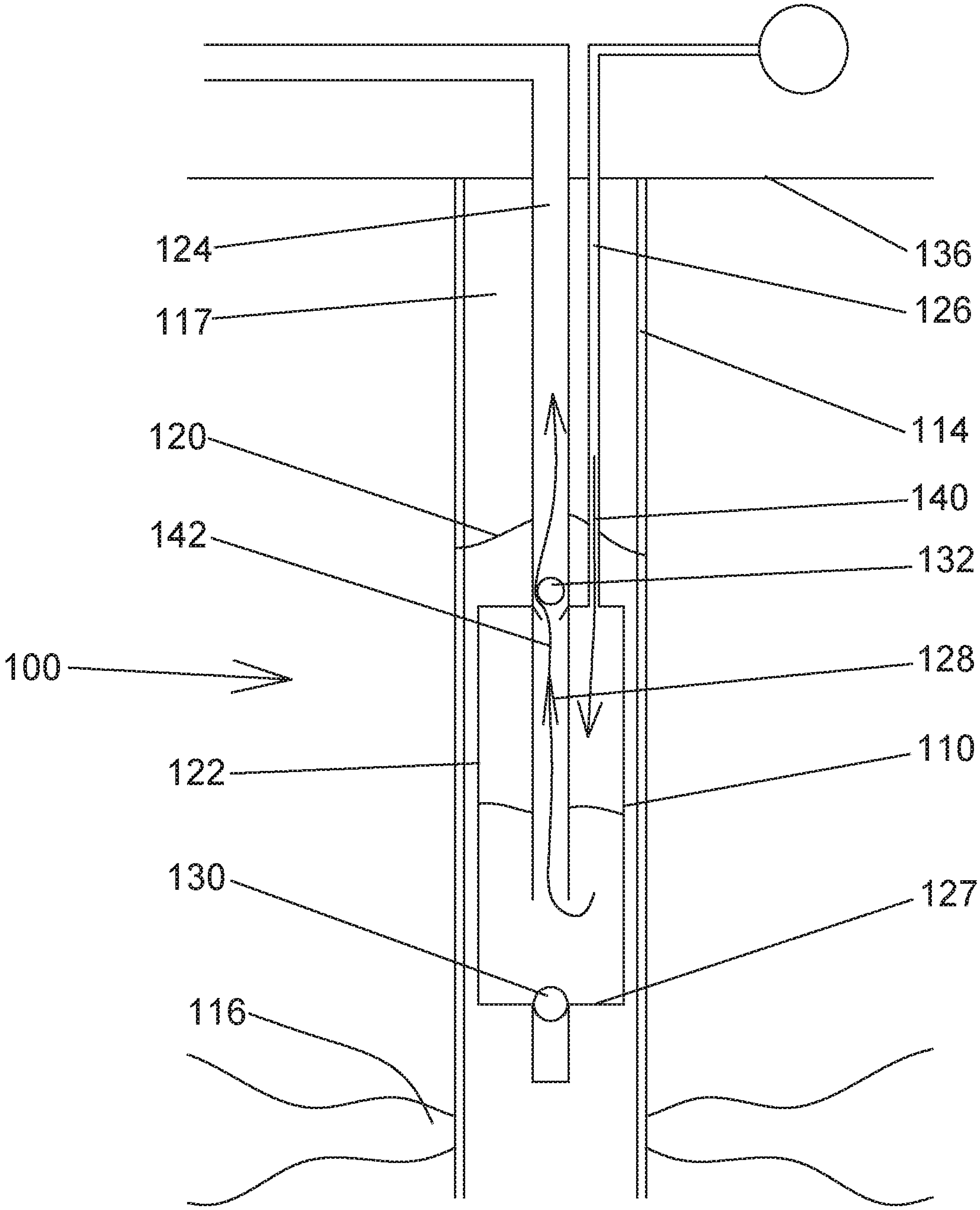



Figure 4
Prior Art

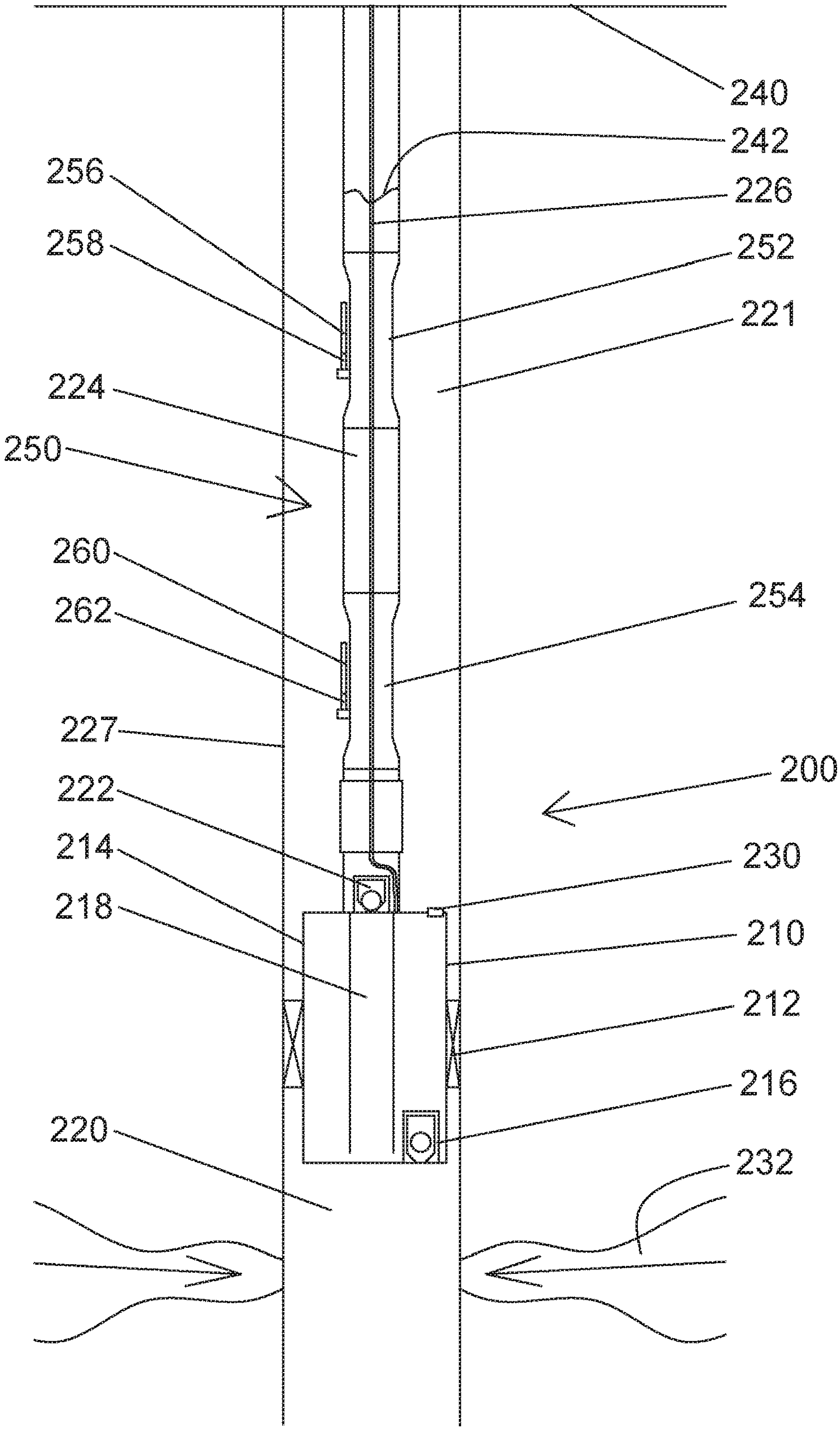

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Figure 5

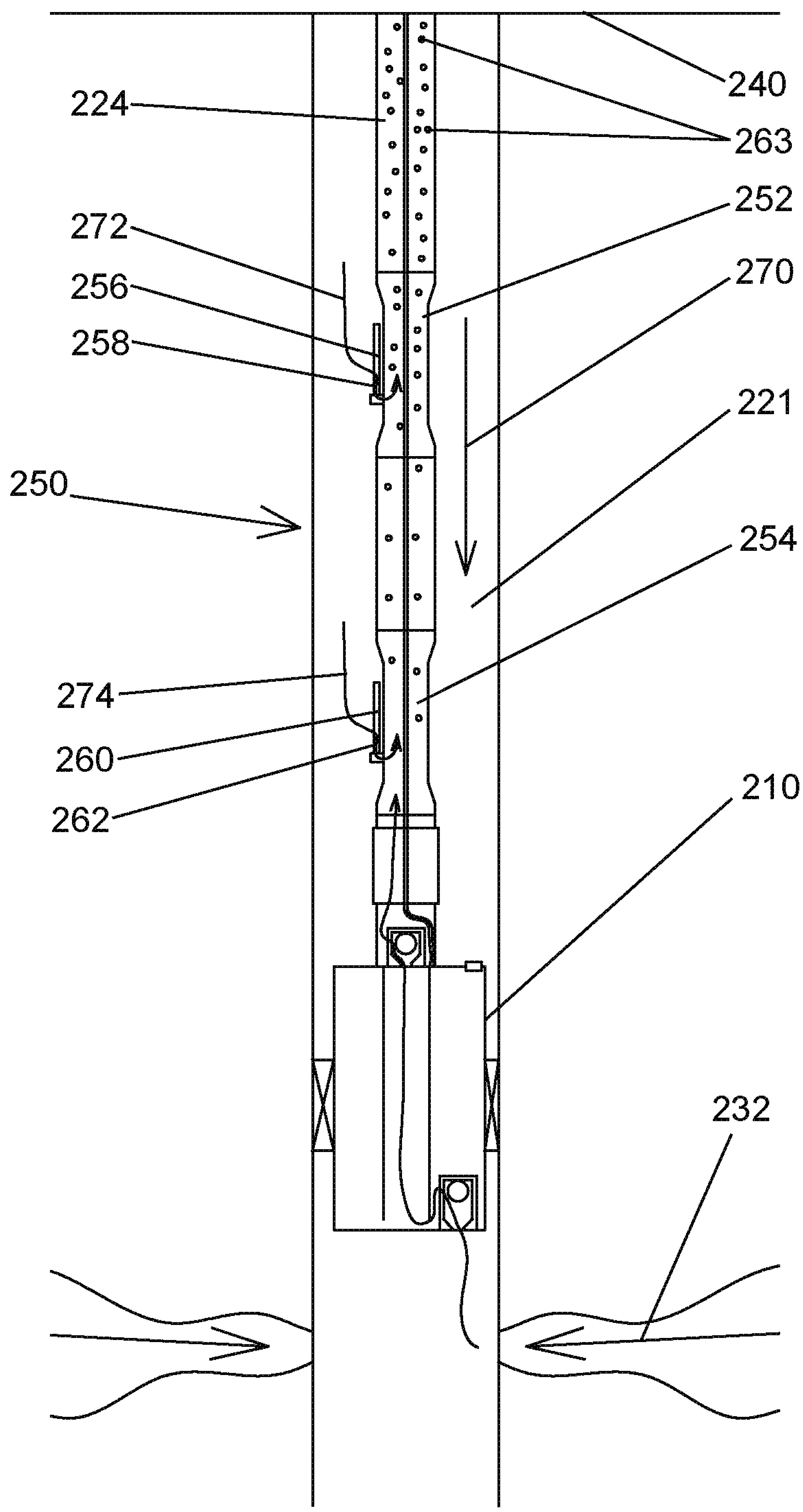
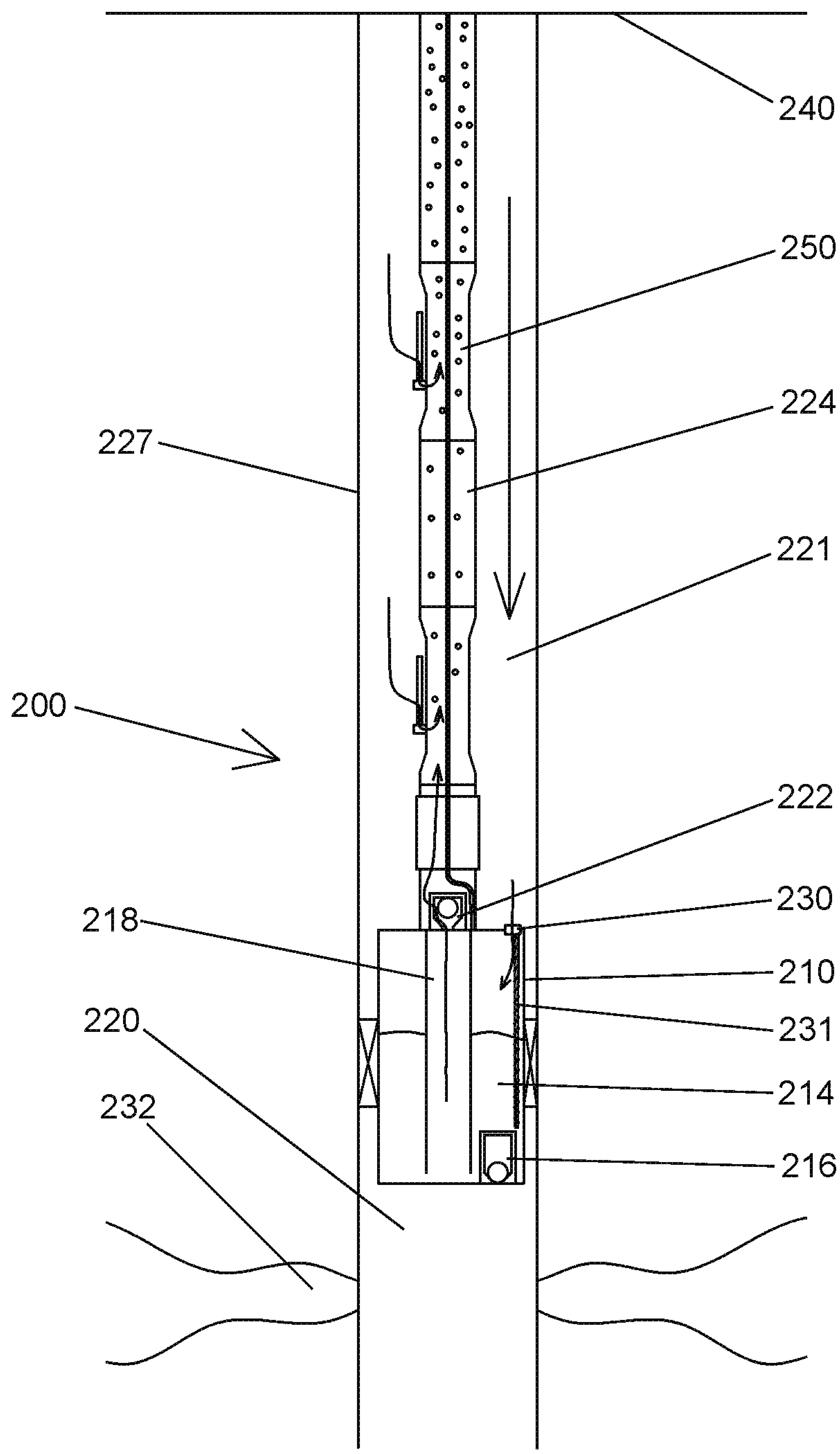



Figure 6

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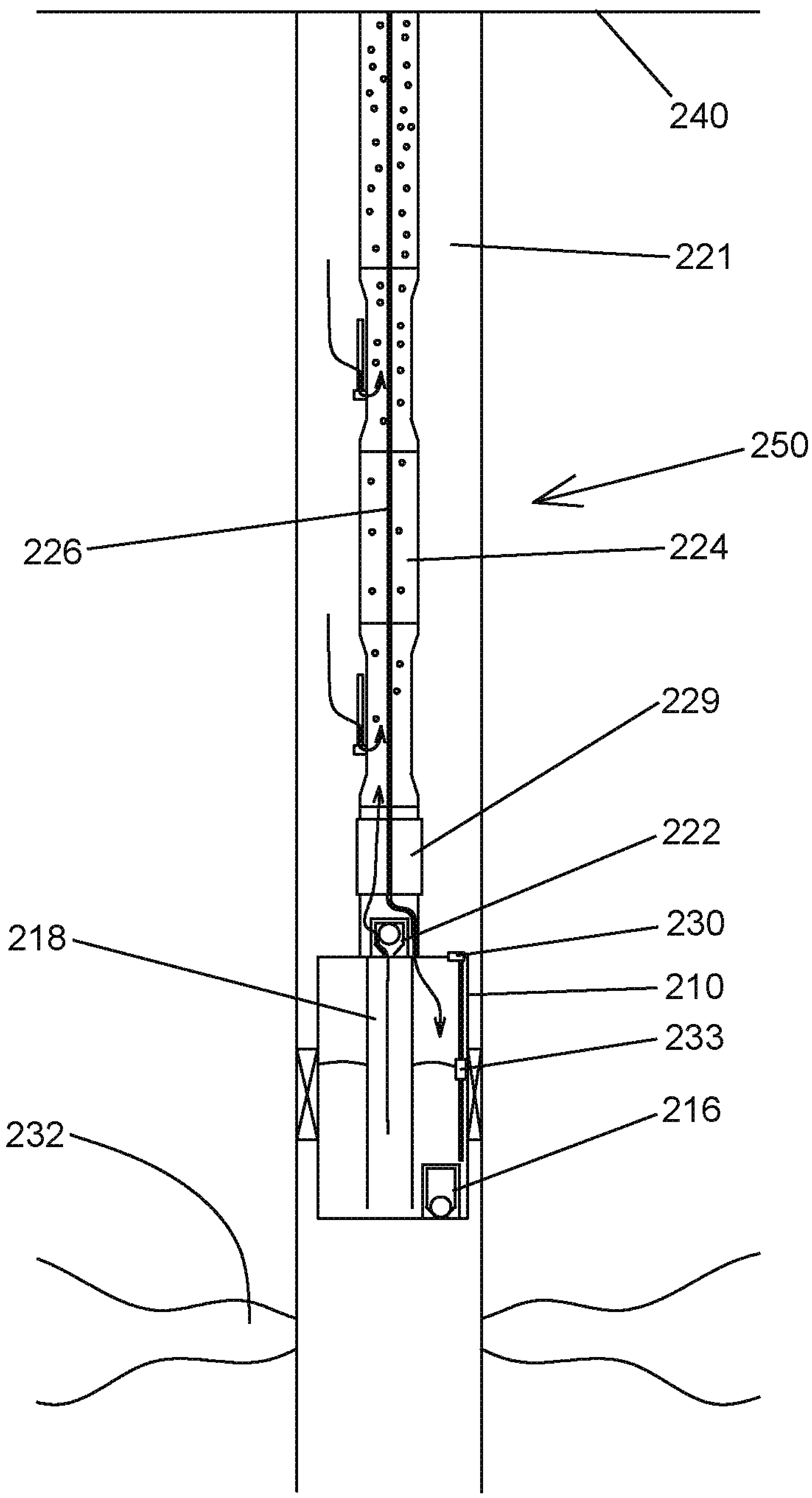


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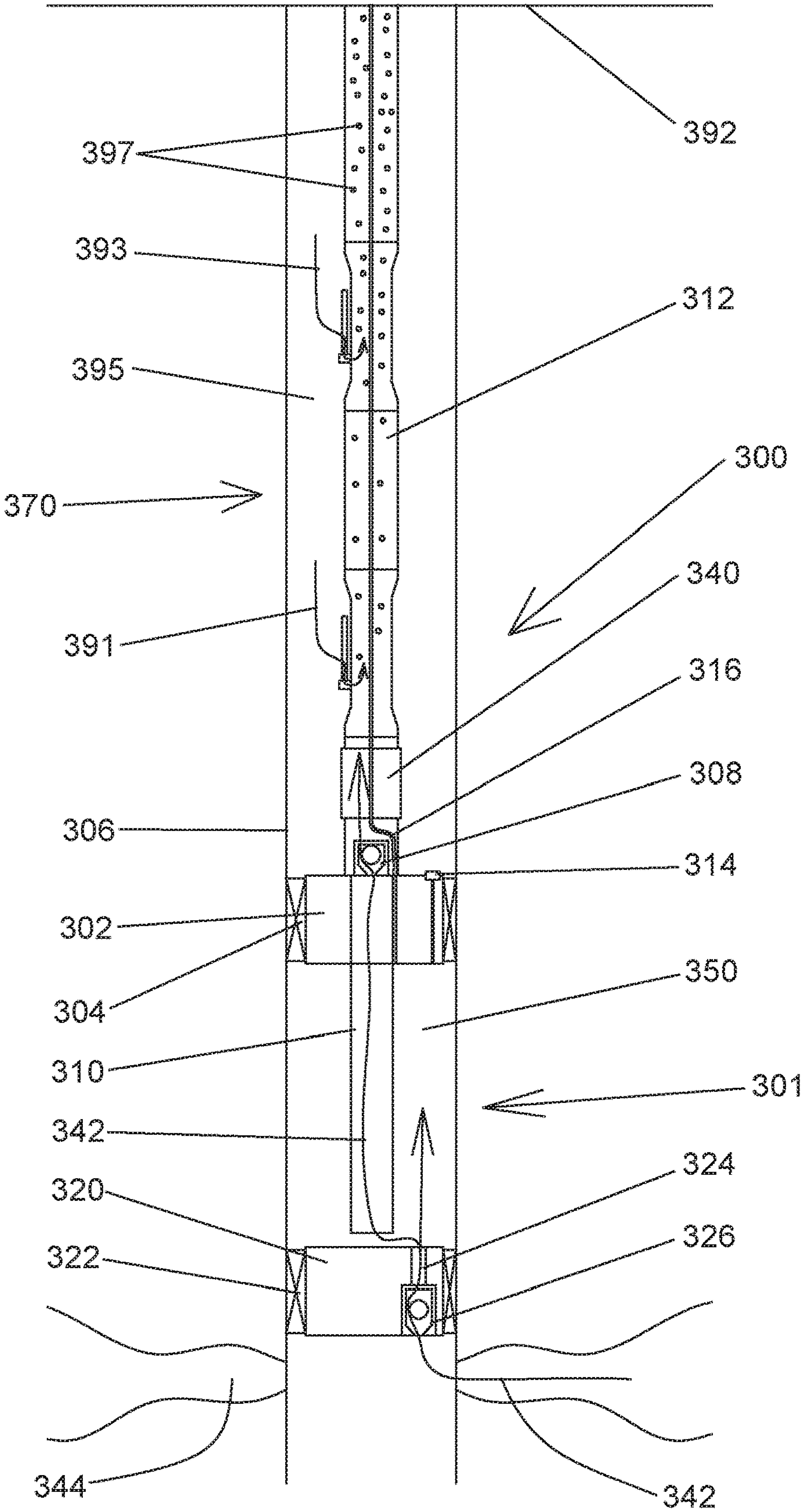
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Figure 9

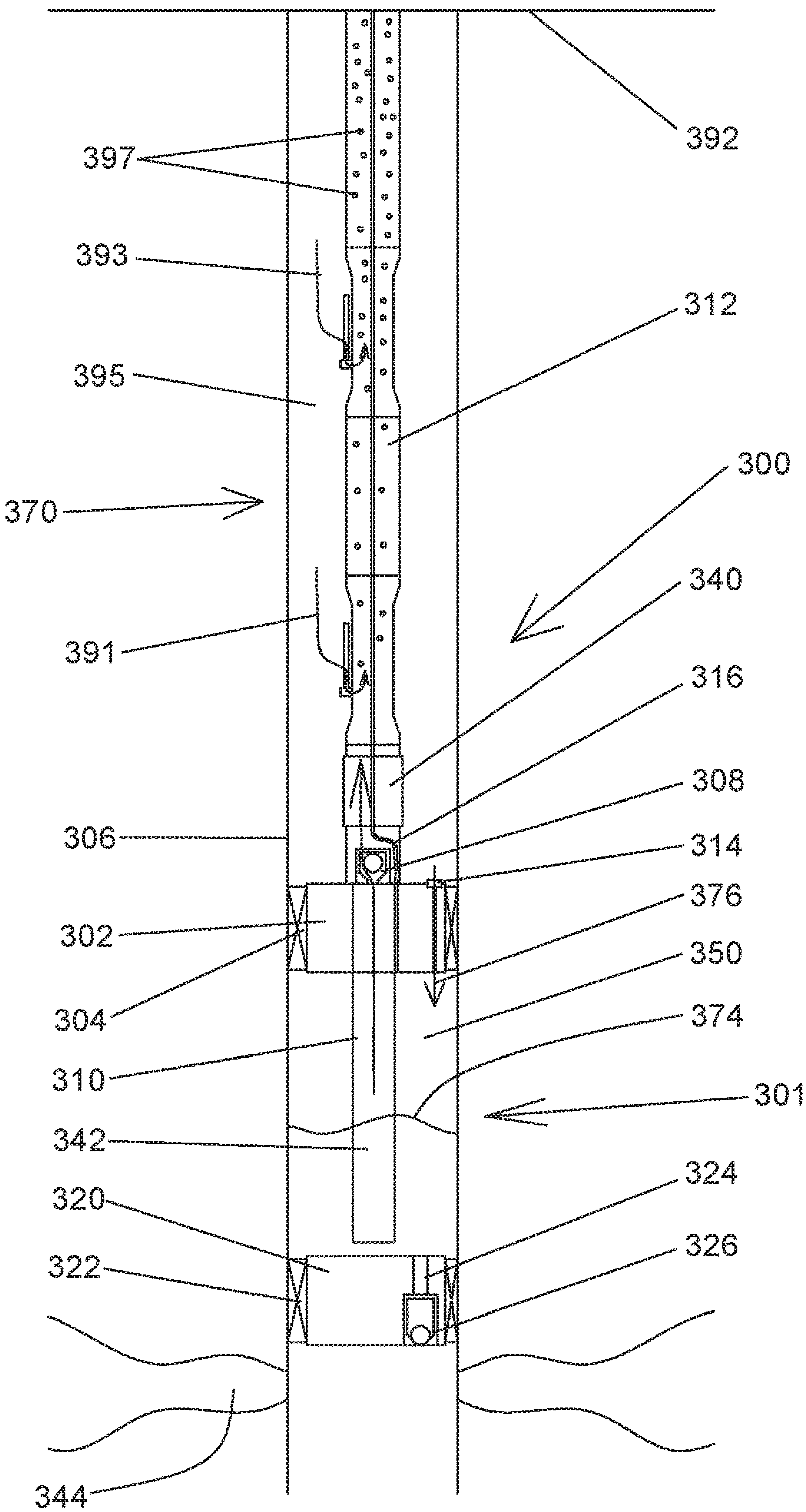
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Figure 10

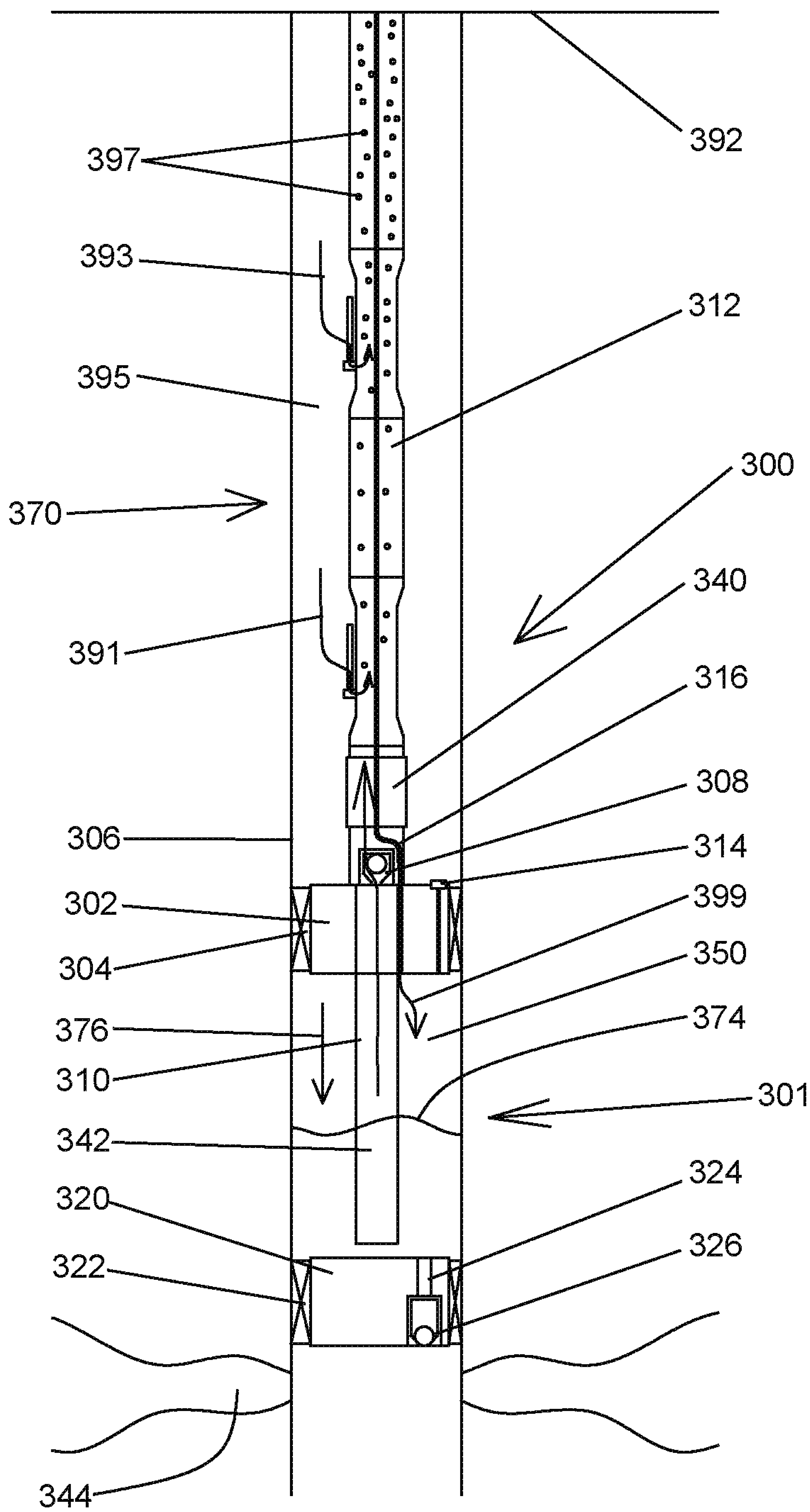
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Figure 11

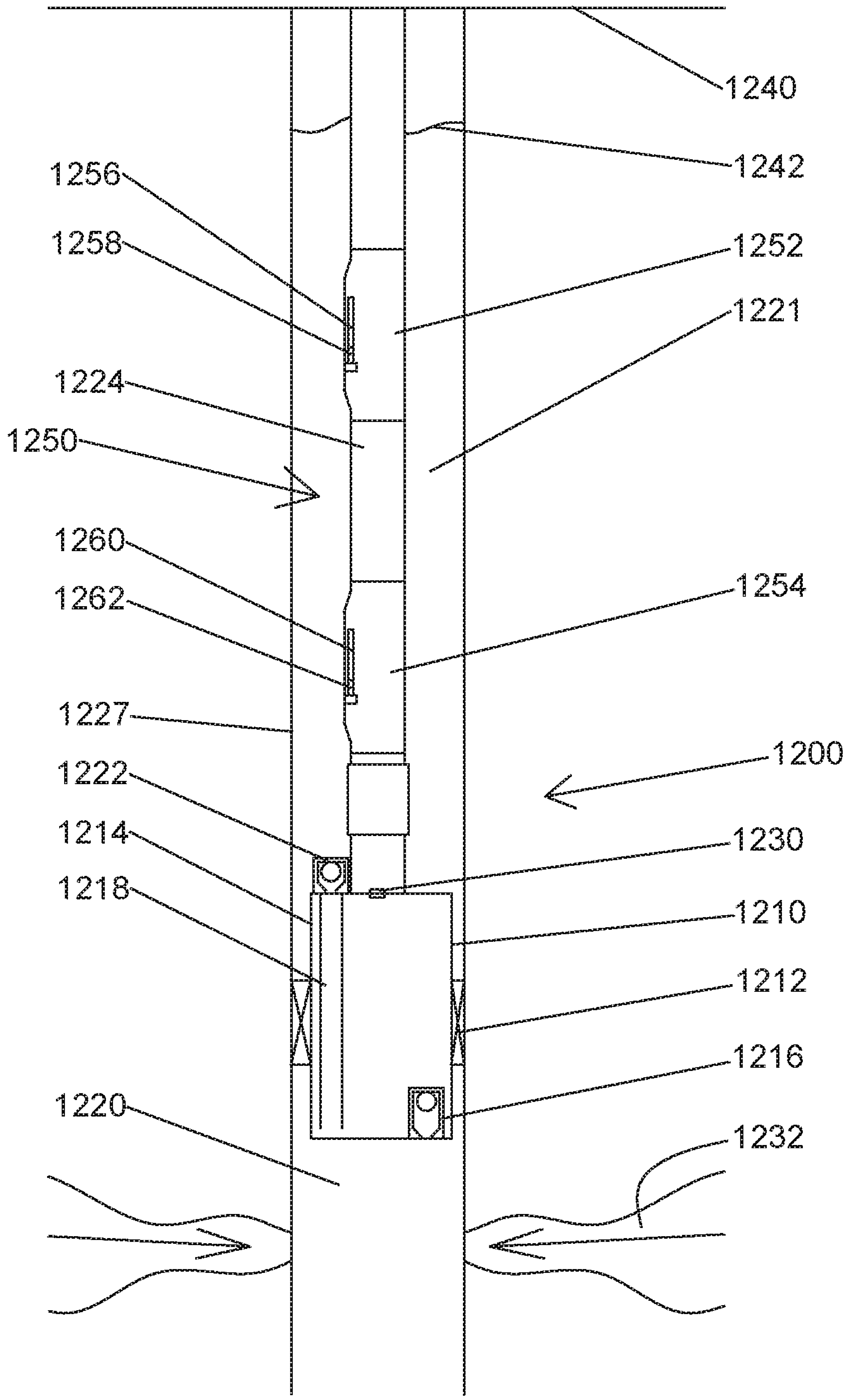
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Figure 12

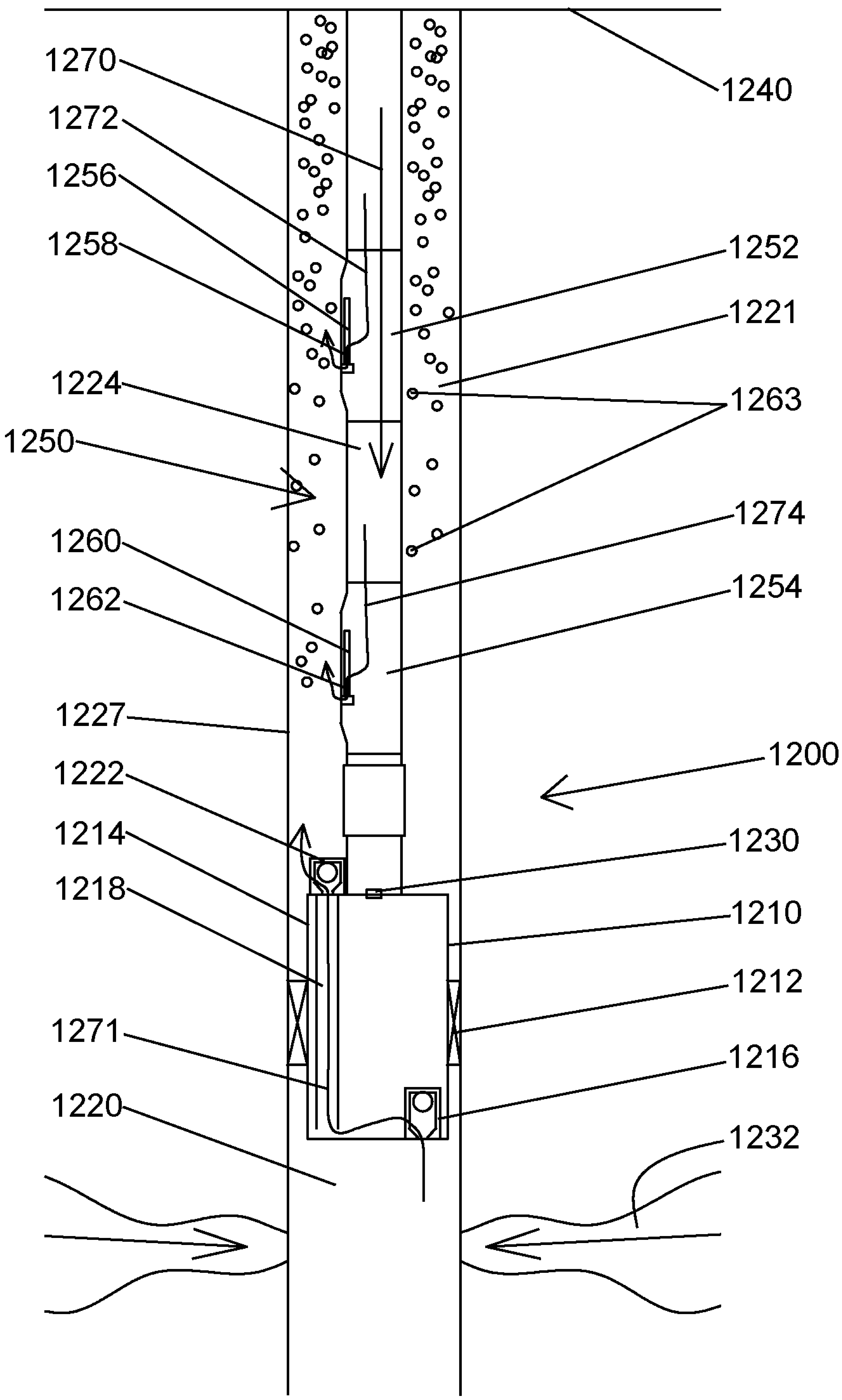
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Figure 13

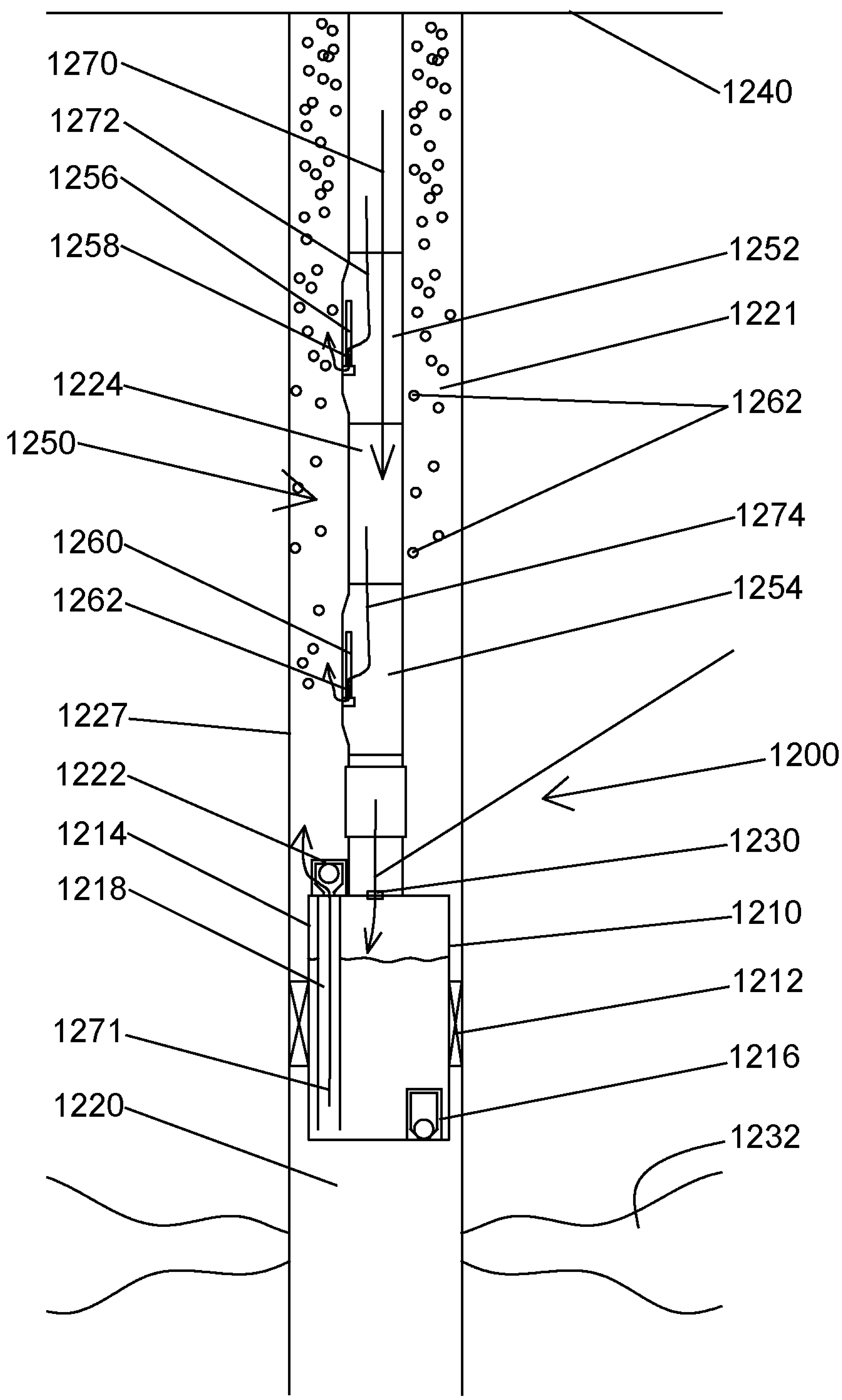
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Figure 14

# HYBRID HYDRAULIC GAS PUMP SYSTEM

## BACKGROUND

At the present time, it is common to permit oil and gas wells to flow under their own natural pressure for as long as they will do so. When the natural flow of fluid from the well has ceased or becomes too slow for economical production, artificial production methods are employed. In many cases, it is advantageous, at least during the first part of the artificial production, to employ gas lift. Numerous types of equipment for producing fluid by gas lift are available. Usually, gas is forced into the annular area between the production tubular and casing, through the production tubular, and finally into the fluid in the production tubular. As the fluid in the production tubular becomes mixed with gas, the density of the fluid decreases. As the density of the fluid decreases the column of fluid weighs less which allows the pressure exerted by the formation to push fluid out of the column or wellbore at the surface. However, removing fluid, even a reduced density fluid, from the wellbore continues to rely upon pressure exerted by the formation. Eventually the wellbore pressure will no longer be able to push the reduced density fluid to the surface and out of the well.

In certain oil wells the oil deposits are highly viscous. These are usually referred to as heavy oil deposits. Heavy oil deposits usually contain high amounts of sand or particulate matter which in combination with heavy oil's high viscosity make such oil deposits essentially immobile and are therefore unable to flow under normal natural drive or primary recovery mechanisms such as gas lift. Steam injection allows heavy oil deposits to be produced. The technique utilizes a second well usually drilled parallel to and relatively close to the first well. A heat source such as steam is placed in the second well in order to heat the well's surroundings, typically a heavy oil deposit. As the heavy oil is heated viscosity of the deposit is reduced allowing the heavy oil to flow towards the first well. Generally, by the heavy oil's viscosity has been reduced to the point where it will flow the heavy oil remains relatively viscous and as previously mentioned include sand or particulate matter. In order to produce such viscous oil and its included particulate matter a hydraulic gas pump may be used. The hydraulic gas pump is able to operate at very low speeds allowing the viscous oil to flow into and through the pump. A hydraulic gas pump, having very few moving parts, allows particulate matter to flow through the pump, material which may otherwise quickly render other pumps inoperable.

## SUMMARY

In order to overcome the limited window of operation of a gas lift system it has been found advantageous to utilize a hydraulic gas pump at the lower end of the gas lift system. When formation pressure is no longer sufficient to push the fluids, including the reduced density fluids, out of the well or when fluid flow out of the well is reduced to the point where it is no longer economically feasible to produce the fluids out of the well, a hydraulic gas pump may be actuated to provide the additional pressure to produce the fluid out of the well. The hydraulic gas pump may be used alone or in conjunction with the gas lift system to lift fluid out of the well.

It is been found that a hybrid system utilizing a hydraulic gas pump at the lower end of the production tubular coupled with a gas lift system to reduce the density of the fluid is able to utilize a single gas source where the pressure has been



optimized so that both systems may operate using the same maximum gas pressure. In such a system typically the lowest gas lift valve is adjacent, or as close as may be practical, to the hydraulic gas pump in order to reduce the required hydraulic gas pump pressure by maximizing the amount of reduced density fluid above the hydraulic gas pump and minimizing the amount of non-reduced density fluid above the hydraulic gas pump. In such a system, both the hydraulic gas pump and the gas lift equipment are installed within the well. In many instances, initially, the gas lift system may be operated independently of the hydraulic gas pump. As the amount of fluid produced at the surface decreases, even with the gas lift system activated, the hydraulic gas pump may be activated to increase the pressure within the production tubular. However, depending upon the well characteristics, the hydraulic gas pump may be operated alone, the gas lift system may be operated alone, the hydraulic gas pump and gas lift system may be operated independently of each other but at the same time, or the hydraulic gas pump and the gas lift system may be operated together preferably optimized for maximum efficiency of the combined system.

Generally, in order to optimize either the hydraulic gas pump or the gas lift system, alone or in conjunction with each other, well data is required. For instance, a temperature sensor at the bottom of the well along with a temperature sensor at the top of the well may allow a determination to be made of fluid, cooling from the bottom of the well to the top of the well which in turn relates to viscosity and fluid flow characteristics through the production tubular. In some instances, it may be advantageous to pump relatively rapidly for a period time such as when pumping warmer fluid more quickly to the surface in order to prevent the dissipation of the fluid's heat into the portion of the wellbore not subjected to outside heating, thereby keeping the fluid's viscosity lower than if allowed to cool. The less viscous fluid requires less force to pump the fluid to the surface.

A pressure sensor at the bottom of the well can be used to determine the effectiveness of the gas lift system, the hydraulic gas pump, or the hybrid gas lift/hydraulic gas pump system. When the gas lift system reduces the density of the fluid column the same pressure sensor maybe used to determine when to actuate the hydraulic gas pump to force fluid into the production tubular under pressure such as when the pressure inside of the hydraulic gas pump reaches the formation pressure during a fill portion of the pumping cycle. The hydraulic gas pump may be considered to be "off" while fluids are filling the hydraulic gas pump chamber. At some point, depending upon the pressure that the bottom hole pressure sensor/s detect external gas pressure is allowed into the hydraulic gas pump chamber to "stroke" or force the fluid inside of the hydraulic gas pump chamber into the production tubular. A simple fluid detector may also be utilized to determine whether the fluid chamber of the hydraulic gas pump was full or empty. When the chamber is emptied or reaches a predetermined level the stroke is stopped. If the chamber is full or at a second predetermined level the stroke is initiated. The fluid detector could be a solid-state detector such as checking the electrical resistance of the fluid in certain locations to determine if fluid was present or not or the fluid detector could be mechanical as in a float. In some instances stroke duration and/or initiation may simply operate on a timer.

In previous hydraulic gas pump systems, the hydraulic gas pump was attached to the production tubular along with a parallel gas supply line. The hydraulic gas pump would then be run into the well on the lower end of both production tubular along with a parallel gas supply line. Unfortunately,

when the two supply lines are run in parallel deploying the parallel lines is challenging and for safety, a special ram needs to be used in the blowout preventer that will sever both lines. If severed retrieving two lines with severed ends in random locations is difficult. In a current embodiment the production tubular and the gas supply line are run concentrically. If the lines are severed or otherwise disconnected a single trip into the well will allow the operator to retrieve the production tubular retrieves both lines simultaneously.

In an embodiment of the hybrid gas lift system where both a hydraulic gas pump and a gas lift system are utilized both systems may operate off of either the annular supplied gas, production tubing supplied gas, or a separate gas line supplied within the production tubular.

In an embodiment of a hydraulic gas pump a gas pump chamber is formed by placing a first plug having a one-way check in the well at the desired location. The one-way check allows flow to pass through the plug from below the plug to above the plug but prevents flow from above the plug to below the plug. A second plug is then set above the first plug. The second plug includes a tubular that extends below the plug. The tubular includes a one-way check valve that allows fluid to into the tubular from the area below the plug, through the one-way check valve, and through the plug to the area above the plug while preventing fluid from flowing from the area above the plug to the area below the plug. The second plug includes a port to allow gas flow through the plug to the area below the plug. The gas may be provided by a dedicated tubular or may be provided by allowing access to either the annular or tubular area above the plug depending upon where gas is provided, in either the annular or tubular area.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** depicts a prior art gas lift system in place but not in operation.

FIG. **2** depicts a prior gas lift system in operation.

FIG. **3** depicts a prior art hydraulic gas pump system in place within a wellbore.

FIG. **4** depicts a portion of the displacement cycle, or stroke, of a hydraulic gas pump system.

FIG. **5** depicts an embodiment of the hybrid hydraulic gas pump system.

FIG. **6** depicts the gas lift portion of the hybrid hydraulic gas pump system in operation.

FIG. **7** depicts the hydraulic gas pump system in a mode of operation where the hydraulic gas pump provides the pressure necessary to push the reduced density fluid to the surface.

FIG. **8** depicts the hydraulic gas pump without a gas supply unit.

FIG. **9** depicts a hybrid hydraulic gas pump having an upper and lower packer along with a portion of the wellbore forming the hydraulic gas pump chamber.

FIG. **10** depicts an alternative embodiment of a hydraulic gas pump providing supplemental pressure to push the reduced density fluid to the surface.

FIG. **11** depicts the hydraulic gas pump utilizing a separate gas supply line within the production tubular.

FIG. **12** depicts an alternate embodiment of the hybrid hydraulic gas pump system.

FIG. **13** depicts the gas lift portion of an alternate embodiment of the hybrid hydraulic gas pump system in operation.

FIG. **14** depicts an alternate embodiment of the hydraulic gas pump system in a mode of operation where the hydraulic gas pump provides the pressure necessary to push the reduced density fluid to the surface.

## DETAILED DESCRIPTION

The description that follows includes exemplary apparatus, methods, techniques, or instruction sequences that embody techniques of the inventive subject matter. However, it is understood that the described embodiments may be practiced without these specific details.

FIG. **1** depicts a prior art gas lift system **10** with the gas lift system **10** in place but not in operation. Generally, a gas lift system **10** is put into operation when the formation **34** no longer has enough pressure to push wellbore fluids from the formation **34** through the production tubular **12** to the surface **36**. In this instance the wellbore fluid flows towards the wellbore **28** as indicated by arrow **38** and is prevented from entering the annular area **22** by packer **32**. The wellbore fluid is allowed to flow into the interior of the production tubular **12** as indicated by arrow **40**. The wellbore fluid will rise within the production tubular **12** to some point such as is indicated by the liquid/gas interface **42** but cannot rise to the surface **36**.

FIG. **2** depicts prior art gas lift system **10** with the gas lift system **10** in operation. The gas lift system **10** has a production tubular **12** inserted into the wellbore **28**. Interspersed along the production tubular **12** are gas lift mandrels **14**. Each of the gas lift mandrels **14** generally includes a gas lift valve **16**, a check valve **18**, and a lug **20**. The lug **20** is welded over a port that provides access between the interior of the gas lift mandrels **14** and the exterior of gas lift mandrel **14**. The lug **20** is welded over the port so that the check valve **18** and or gas lift valve **16** may be threaded into the lug **20** allowing gas to flow through the gas lift valve **16** between the annular area **22** and the interior **24** of the production tubular **12**. The annular area **22** is the area between the wellbore wall **26** and the exterior of the production tubular **12**. The wellbore wall **26** in most instances is cased. A packer **32**, if used, may be near the lower end **30** of the production tubular **12**. Gas such as nitrogen, carbon dioxide, or natural gas is pumped into the annular area **22** as indicated by arrow **44**. The gas then flows into one of the gas lift valves **16**, through the gas lift valve **16**, through the check valve **18** through the lug **20** and into the interior of a gas lift mandrel **14** as indicated by arrow **47**. The gas then creates bubbles **46** which serve to reduce the overall density of the wellbore fluid within the production tubular **12** allowing the formation pressure to push the now reduced density fluid to the surface **36**.

FIG. **3** depicts a prior art hydraulic gas pump system **100** in place within a wellbore **110**. The wellbore **110** has a casing **114**, the formation **116** provides fluid that flows into the interior **117** of the wellbore **110** and continues towards the surface **136** until the column of fluid within the wellbore **110** exerts sufficient downward pressure to balance the pressure at the formation **116**. Once the pressure exerted by the column of fluid equals the pressure at the formation **116** the column of fluid stops rising at the fluid/gas interface **120**. Usually the hydraulic gas pump chamber **122** is placed well below the fluid gas interface **120** so that the entire chamber **122** is submerged within the fluid. The chamber **122** is attached to the lower end of a production tubular **124** and to a parallel gas supply line **126**. Within the chamber **122** is a tube **128** that extends towards the lower end **127** of the chamber **122**. At the lower end of chamber **122** is a check valve **130** that allows fluid to flow into the chamber **122** from the exterior to the interior of chamber **122** but does not allow fluid to flow from the interior of chamber **122** to the exterior of chamber **122**. Chamber **122** has a second check valve **132**. Fluid may flow from the interior of chamber **122** into tubular **128** and through check valve **132** to enter into production tubular **124**. The second check valve **132** allows fluid to flow from chamber **122** into production tubular **124** but does not allow fluid to flow from production tubular **124** back into chamber **122**. The gas supply line **126** is attached chamber **122** so that pressurized gas from the gas supply line **126** may intermittently enter into the interior of chamber **122** displacing fluid from chamber **122**.

The hydraulic gas pump system **100** is in the fill cycle of an effective stroke of the hydraulic gas pump system **100**. The gas supplied through gas supply line **126** is off, check valve **132** is closed so that fluid may not enter chamber **122** from the production tubular **124**, while check valve **130** is open allowing fluid from the exterior of chamber **122** to enter into the interior of chamber **122** through the now open check valve **130**. As seen in FIG. **3** chamber **122** is relatively full of fluid.

FIG. **4** depicts a portion of the displacement cycle of an effective stroke of the hydraulic gas pump system **100**. The gas supply through gas supply line **126** is on allowing high-pressure gas to flow into chamber **122** as indicated by arrow **140**. Check valve **130** is now closed so that fluid may not exit from the interior of chamber **122** to the exterior of chamber **122**. Check valve **132** is open so that the fluid displaced by the high-pressure gas flowing into the chamber **122** can flow into tubular **128** through check valve **132** and a production tubular **124** as indicated by arrow **142**.

FIG. **5** depicts an embodiment of the hybrid hydraulic gas pump **200**. The hybrid hydraulic gas pump **200** includes a hydraulic gas pump **210**. Hydraulic gas pump **210** may include a packer such as packer **212**. The packer **212** is depicted as being adjacent to the hydraulic gas pump body **214**. The packer **212** is depicted as sealing the annular area between the hydraulic gas pump body **214** and the wellbore wall **227**. The packer **212** prevents fluid from moving from below the hydraulic gas pump body **214**, through the annular area between the hydraulic gas pump body **214** and the wellbore wall **227**, to the area above the hydraulic gas pump body **214**. In many instances a packer is not used in conjunction with the hybrid hydraulic gas pump **200**. Hydraulic gas pump body **214** includes a first check valve **216**. The first check valve **216** allows fluid to flow into the interior of the hydraulic gas pump body **214**. The first check valve **216** may be a simple caged ball check valve, a spring-loaded check valve, or other valve that operates to allow fluid to flow into the interior of the hydraulic gas pump body and then to close on command such as when gas is being allowed into the interior of the hydraulic gas pump body to force the fluid to the surface. Hydraulic gas pump body **214** usually includes a pickup tube **218**.

As shown in FIG. **5** the hydraulic gas pump **210** may be considered either not in operation or on an effective fill cycle. The hydraulic gas pump **210** is generally mounted as close to formation **232** as practical. In certain instances, the hydraulic gas pump **210** would be mounted below the formation **232**. By locating the hydraulic gas pump **210** as close to the formation as practical wellbore fluid is able to move from the formation **232** to the interior of the hydraulic gas pump body **214**, even in the absence of significant pressure from the formation. Formation fluid moves from the formation to the lower end of the hydraulic gas pump **210**. The fluid may then flow into the interior of the hydraulic gas pump body through check valve **216**, where check valve **216** allows fluid to move into the interior of the hydraulic gas pump body **214** but prevents fluid from moving from the interior of the hydraulic gas pump body **214** to the exterior of the hydraulic gas pump body **214**. As the fluid fills or moves through the interior of the hydraulic gas pump body the fluid will also fill pickup tube **218**. Provided there is sufficient pressure from the formation **232** the fluid will continue to move from the pickup tube **218** through the upper check valve **222** and into the production tubular **224**. Early in the life of the well pressure from the formation **232** may be sufficient to push the wellbore fluid all the way to the surface **240**. However, eventually, pressure in the formation **232** will no longer be sufficient to push fluid to the surface **240** and will only push fluid part way to the surface, in this instance as shown by the gas fluid interface **242**.

The hybrid hydraulic gas pump system includes a conventional injection pressure operated gas lift system **250** installed along the length of the production tubular **224** in conjunction with the hydraulic gas pump **210**. While a conventional injection pressure operated gas lift system is depicted, any type of gas lift system may be used in conjunction with hydraulic gas pump **210**. In this instance a first gas lift mandrel **252** and a second gas lift mandrel **254** are installed as part of the production tubular **224**. A first gas lift valve **256** is attached to the first gas lift mandrel **252**. Usually, but not always, a gas lift valve has a check valve attached between the gas lift valve in the mandrel. The check valve prevents any fluid or other flow from the interior of the mandrel and/or production tubular towards the check valve in the exterior or the primary annular area **221** between the wellbore wall **227** and the production tubular **224**. In this case first check valve **258** is between the first gas the valve **256** and the first gas lift mandrel **252**. Also depicted is a second gas lift valve **260**, a second gas lift mandrel **254**, and a second check valve **262** between the second gas lift valve **260** and the second gas lift mandrel **254**. As depicted the wellbore fluid has risen to the fluid gas interface **242** but formation pressure is no longer sufficient to push fluid to the surface **240**.

FIG. **6** depicts the gas lift **250** portion of the hybrid hydraulic gas pump system in operation. During this initial stage of gas lift the fluid column within the production tubular **224** needs to be lightened in order to allow the formation pressure to push the fluid to the surface **240**. Gas is injected into the primary annular area **221** as depicted by arrow **270**. As depicted by arrow **272** injected gas flows from the primary annular area **221** through the first gas lift valve **256**, through the first check valve **258**, and into the interior of the first gas lift mandrel **252**. The gas then becomes interspersed within the wellbore fluid, usually in the form of bubbles such as bubbles **263**. With the bubbles **263** dispersed within the fluid within the production tubular **224** the overall density of the fluid within the production tubular **224** is reduced allowing the formation pressure to once again push the fluid to the surface **240**. In certain instances a single gas lift point such as the first gas lift point provided by first gas lift valve **256**, first check valve **258**, and the first gas lift mandrel **252** is not able to sufficiently reduce the overall density of the wellbore fluid to allow the fluid to be produced to the surface **240**. Usually multiple gas lift points are included along the length of the production tubular **224**. A second gas lift point is depicted as being provided by second gas lift valve **260**, second check valve **262**, and second gas lift mandrel **254**. With respect to the second gas lift point, gas flow, as depicted by arrow **274**, flows from the primary annular region **221** into the second gas lift valve **260** through the second check valve **262** and into the second mandrel **254** where the gas becomes interspersed within the wellbore fluid.

Eventually formation pressure within reservoir **232** diminishes to the point where the formation pressure is no longer able to push the fluids to the surface even with gas lift reducing the density of the fluid column. It is envisioned that in such an instance a hydraulic gas pump **210** may provide the additional pressure necessary to push the fluid column to the surface **240** in conjunction with the gas lift system **250**.

FIG. **7** depicts the hybrid hydraulic gas pump system **200** in a mode of operation where the hydraulic gas pump **210**, replacing the pressure provided by the formation **232**, provides the pressure necessary to push the reduced density fluid to the surface **240**. In this case the reduced density fluid is being created due to the gas lift system **250** in operation within the wellbore **220**. While in certain instances the hydraulic gas pump **210** is capable of providing sufficient pressure to force the wellbore fluid to the surface singly, the use of the gas lift system **250** to reduce the density of the fluid column reduces the overall energy requirements to move the fluids to the surface as the hydraulic gas pump **210** requires less pressure to move the reduced density fluids to the surface as compared to moving the same fluid, but without the injected gas to reduce the density of the fluid, the same distance to the surface. Typically the lowest gas lift point, in this case the gas lift point provided by second gas lift valve **260**, second check valve **262**, and second gas lift mandrel **254**, are placed as close as possible to the hydraulic gas pump **210** in order to minimize the amount of full density wellbore fluid between the hydraulic gas pump **210** and the second gas lift mandrel **254**. Any full density fluid within production tubular **224** between gas lift pump **210** and second mandrel **254** increases the weight of the fluid column and thus the pressure required to lift the fluid to the surface **240** and thus increases the amount of energy required to operate the system. The lower the required pressure, the lower the energy cost to lift the fluid to the surface. Generally, the gas pressure is provided by compressors on the surface.

In the hydraulic gas pump **210** mode of operation shown in FIG. **7** the gas supply unit **230** generally includes a valve that opens during the effective pump cycle and closes during the effective fill cycle. The gas supply unit **230** may operate independently downhole or may be operated from the surface. The gas supply unit **230** may operate simply on a timed cycle. The timer may be electrical or mechanical. In some instances, the operation of gas supply unit **230** is based on sensing the fluid level within the hydraulic gas pump body **214**. The fluid level may be sensed electrically such as by sensing resistance of the fluid **231** or may be mechanical **233**, in FIG. **8**, such as having a float within hydraulic gas pump body **214** to trigger the gas supply unit **230** open as the hydraulic gas pump body **214** reaches the desired fill level and then triggering the gas supply unit **230** to close as the fluid level within the hydraulic gas pump body **214** reaches the second desired fill level although any sensing mechanism may be used. With the gas supply unit **230** open, pressurized gas from the primary annular region **221** flows from the primary annular region **221** through the gas supply unit **230** and into the interior of the hydraulic gas pump body **214**. The pressurized gas flowing into the hydraulic gas pump body **214** displaces the fluid within the hydraulic gas pump body from the top down. As the fluid is displaced the first check valve **216** will close. As additional pressurized gas enters the hydraulic gas pump body **214** through the gas supply unit **230** the fluid within the hydraulic gas pump body **214** flows into pickup tube **218**, through the open second check valve **222** and into production tubular **224** where with the assistance of the gas lift system **250** the fluid is produced to the surface **240**. As the hydraulic gas pump body **214** is emptied of fluid the gas supply unit **230** closes in response to the timer, the fluid sensor, or other signal and the cycle is repeated where as depicted in FIG. **6**, the gas supply unit **230** is shut off and wellbore fluid is allowed to refill the hydraulic gas pump body **214** through check valve **216**.

In the hydraulic gas pump **210** second mode of operation shown in FIG. **8** the gas supply unit **230** may or may not be included in the installation. In the second mode of operation pressurized gas is supplied to the hydraulic gas pump **210** via gas supply line **226**. Where gas supply line **226** is generally concentric with but is at least within the production tubular **224**. As gas supply line **226** reaches coupling **229** the gas supply line **226** enters the hydraulic gas pump **210** and may be routed as necessary within the hydraulic gas pump **210**. Generally, the gas supply line **226** provides pressurized gas to the hydraulic gas pump body **214** during the effective pump cycle and the pressurized gas supply ceases during the effective fill cycle. The gas supply line **226** may operate simply on a timed cycle. The timer may be electrical or mechanical. In some instances the operation of gas supply line **226** is based on sensing the fluid level within the hydraulic gas pump body **214**. The fluid level may be sensed electrically such as by sensing resistance of the fluid or may be mechanical such as having a float within hydraulic gas pump body **214** to trigger the gas supply line **226** to supply pressurized gas to the hydraulic the gas pump body **214** as the hydraulic gas pump body **214** reaches the desired fill level and then triggering the gas supply line **226** to cease supplying pressurized gas two the hydraulic gas pump body **214** as the fluid level within the hydraulic gas pump body **214** reaches the second desired fill level. With the gas supply line **226** open pressurized gas from the surface **240** flows through the gas supply line **226** and into the interior of the hydraulic gas pump body **214**. As the fluid is displaced the first check valve **216** will close. As additional pressurized gas enters the hydraulic gas pump body **214** through the gas supply unit **230** the fluid within the hydraulic gas pump body flows into pickup tube **218**, through the open second check valve **222** and into production tubular **224** where with the assistance of the gas lift system **250** the fluid is produced to the surface **240**. As the hydraulic gas pump body **214** is emptied of the fluid the gas supply line **226** ceases supplying pressurized gas to the hydraulic gas pump body **214** in response to the timer, the fluid sensor, or other signal and the cycle is repeated where as depicted in FIG. **6**, the gas supply line **226** is shut off and wellbore fluid is allowed to refill the hydraulic gas pump body **214** through check valve **216**.

FIG. **9** depicts an alternative embodiment of a hybrid hydraulic gas pump system **300**. The hydraulic gas pump **301** includes a first packer **302**. The first packer **302** has a first sealing element **304**. The first sealing element **304** provides a gas tight seal between the first packer **302** and the wellbore wall **306**. The wellbore wall **306** may be cased or uncased. The first packer **302** includes a pickup tube **310**. The first packer **302** also includes a first check valve **308**. The first check valve **308** allows one-way fluid flow from pump chamber **350** through the pickup tube **310** to the region above first packer **302**. Pickup tube **310** is provided so that fluid at some distance below first packer **302** may flow from the lower end of pickup tube **310**, through pickup tube **310**, through first packer **302**, and through first check valve **308**. While check valve **308** is typically provided at the upper end of first packer **302** the check valve **308** may be provided at any point from the lower end of pickup tube **310**, through first packer **302**, to the top of packer **302**. In some instances, the check valve **308** may be provided within production tubular **312**. The first packer **302** also includes a gas supply unit **314** and a gas supply line **316** to provide alternate modes of operation. In some instances only a gas supply unit **314** or a gas supply line **316** may be installed in packer **302**.

The first packer **302** is coupled to the production tubular **312** via coupling **340**. While coupling **340** is depicted as linking the first packer **302** to the production tubular **312** other means of connecting the first packer **302** to the production tubular **312** may be used and include but are not limited to welding and threaded connections.

The hydraulic gas pump **301** includes a second packer **320**. The second packer **320** has a second sealing element **322**. The second sealing element **322** provides a gas tight seal between the second packer **320** and the wellbore wall **306** to prevent fluid or gas flow past the second packer **320** in either direction. The wellbore wall **306** may be cased or uncased. The second packer **320** also includes a throughbore **324**. Throughbore **324** includes a second check valve **326**. Second check valve **326** allows fluid to flow from below the second packer **320** through throughbore **324** to the region above second packer **320** while preventing fluid flow from the region above second packer **322** the region below second packer **320**.

The first packer **302** is shown having gas supply line **316** extending through and coaxial with production tubular **312**. Once the gas supply line **316** reaches the first packer **302** the gas supply line **316** may be routed as necessary through the first packer **302**. Alternatively, a gas supply unit **314** is depicted on an upper end of the first packer **302**.

The hydraulic gas pump **301** has not been actuated but may be considered to be in a fill stroke. The hydraulic gas pump **301** utilizes the region between first packer **302** and second packer **320** as the pump chamber **350**. As depicted by arrow **342** fluid flows from formation **344** toward second packer **320**. The fluid then flows past check valve **326** through throughbore **324** and into pump chamber **350**. Some fluid fills chamber **350** while a portion of the fluid enters fill tube **310** and proceeds upwards towards packer **302**. If sufficient pressure exists within formation **344** the fluid may continue past packer **302** through check valve **308** and into production tubular **312** rising to some point towards the surface past packer **302**. Gas is injected into the primary annular area **395**. As depicted by arrows **393** and **391** injected gas flows from the primary annular area **395** into the interior of the production tubular **312**. The gas then becomes interspersed within the wellbore fluid, usually in the form of bubbles such as bubbles **397**. In some instances the formation pressure along with the reduced density of the wellbore fluid provided by gas lift system **370** may be sufficient to produce the fluid to the surface **392**. If there is insufficient pressure to produce the fluid to the surface **392** hydraulic gas pump **300** may be actuated.

FIG. **10** depicts hybrid hydraulic gas pump system **300** in a mode of operation where the hydraulic gas pump **301**, replacing the pressure provided by the formation **344**, provides the pressure necessary to push the reduced density fluid to the surface **392**. In this case the reduced density fluid is being created due to the gas lift system **370** in operation within the wellbore **306**.

In the hydraulic gas pump **300** mode of operation shown in FIG. **10** the gas supply unit **314** generally includes a valve that opens during the effective pump cycle and closes during the effective fill cycle. The gas supply unit **314** may operate independently downhole or may be operated from the surface. With the gas supply unit **314** open, pressurized gas from the annular region **374** flows from the primary annular region **221** through the gas supply unit **230** and into the interior of the hydraulic gas pump body **214**.

The pressurized gas flowing into the pump chamber **350** displaces the fluid within the pump chamber **350** such that the gas fluid interface **374** moves lower within the pump chamber **350** from the top down as indicated by arrow **376**. As the fluid is displaced the first check valve **308** will open to allow the fluid to move out of the pump chamber **350** and into the production tubular **312** and then towards the surface **392**. While the second check valve **326** closes in response to the fluid flow thereby preventing fluid flow out of the pump chamber **350** and back towards formation **344**.

As additional pressurized gas enters the gas pump chamber **350** through the gas supply unit **314** the fluid within the gas pump chamber **350** flows into pickup tube **310**, through the open first check valve **308** and into production tubular **312** where with the assistance of the gas lift system **370** the fluid is produced to the surface **392**. As the gas pump chamber **350** is emptied of fluid the gas supply unit **314** closes and wellbore fluid is allowed to refill the gas pump chamber **350** through check valve **326**.

FIG. **11** depicts the hydraulic gas pump **300** in a second mode of operation. The gas supply unit **314** may or may not be included in the installation. In the second mode of operation pressurized gas is supplied to the hydraulic gas pump **300** via gas supply line **316**. Where gas supply line **316** is concentric within production tubular **312**. Generally the gas supply line **316** provides pressurized gas to the hydraulic gas pump body **300** during the effective pump cycle and the pressurized gas supply ceases during the effective fill cycle. With the gas supply line **316** open, pressurized gas from the surface **392** flows through the gas supply line **316** and into the gas pump chamber **350** as depicted by arrow **399**. The pressurized gas flowing into the gas pump chamber **350** displaces the fluid within the gas pump chamber **350** at the fluid gas interface **374** from the top down. As the fluid is displaced the first check valve **326** closes. As additional pressurized gas enters the gas pump chamber **350** the fluid within the gas pump chamber **350** flows into pickup tube **310**, through the open first check valve **308** and into production tubular **312** where with the assistance of the gas lift system **370** the fluid is produced to the surface **392**. As the gas pump chamber **350** is emptied of fluid, the gas supply line **316** ceases supplying pressurized gas to the gas pump chamber **350** allowing the gas pump chamber to refill through check valve **326**.

FIG. **12** depicts an alternate embodiment of the hybrid hydraulic gas pump system **1200** where pressurized gas is supplied to both the hybrid hydraulic gas pump **1210** and the gas lift valves **1256** and **1260** via tubular **1224** and is produced to surface via the primary annular area **1221**. The hybrid hydraulic gas pump system **200** includes a hybrid hydraulic gas pump **1210**. Hybrid hydraulic gas pump **1210** may include a packer such as packer **1212**. The packer **1212** is depicted as being adjacent to the hybrid hydraulic gas pump body **1214**. The packer **1212** is depicted as sealing the annular area between the hybrid hydraulic gas pump body **1214** and the wellbore wall **1227**. The packer **1212** prevents fluid from moving past the hybrid hydraulic gas pump body **1214**. Hybrid hydraulic gas pump body **1214** includes a first check valve **1216**. The first check valve **1216** allows fluid to flow into the interior of the hybrid hydraulic gas pump body **1214**. The first check valve **1216** may be a simple caged ball check valve, a spring-loaded check valve, or other valve that operates to allow fluid to flow into the interior of the hybrid hydraulic gas pump body and then to close on command such as when gas is being allowed into the interior of the hybrid hydraulic gas pump body to force the fluid to the surface. Hybrid hydraulic gas pump body **1214** usually includes a pickup tube **1218**.

As shown in FIG. **12** the hybrid hydraulic gas pump **1210** may be considered either not in operation or on an effective fill cycle. The hybrid hydraulic gas pump **1210** is generally mounted as close to formation **1232** as practical. In certain instances, the hybrid hydraulic gas pump **1210** would be mounted below the formation **1232**. By locating the hybrid hydraulic gas pump **1210** as close to the formation as practical wellbore fluid is able to move from the formation **1232** to the interior of the hybrid hydraulic gas pump body **1214**, even in the absence of significant pressure from the formation. Formation fluid moves from the formation to the lower end of the hybrid hydraulic gas pump **1210**. The fluid may then flow into the interior of the hybrid hydraulic gas pump body through check valve **1216**, where check valve **1216** allows fluid to move into the interior of the hybrid hydraulic gas pump body **1214** but prevents fluid from moving from the interior of the hybrid hydraulic gas pump body **1214** to the exterior of the hybrid hydraulic gas pump body **1214**. As the fluid fills or moves through the interior of the hybrid hydraulic gas pump body **1214** as indicated by arrow **1271** the fluid will also fill pickup tube **1218**. Provided there is sufficient pressure from the formation **1232** the fluid will continue to move from the pickup tube **1218** through the upper check valve **1222** and into the primary annular area **1221**. Early in the life of the well, pressure from the formation **1232** may be sufficient to push the wellbore fluid all the way to the surface **1240**. However, eventually, pressure in the formation **1232** will no longer be sufficient to push fluid to the surface **1240** and will only push fluid part way to the surface, in this instance as shown by the gas fluid interface **1242**.

The hybrid hydraulic gas pump system **1200** includes a reverse flow **1250** installed along the length of the tubular **1224** in conjunction with the hybrid hydraulic gas pump **1210**. In this instance a first gas lift mandrel **1252** and a second gas lift mandrel **1254** are installed as part of the tubular **1224**. A first gas lift valve **1256** is attached to the first gas lift mandrel **1252**. Usually, but not always, a gas lift valve has a check valve attached between the gas lift valve in the mandrel. The check valves **1258** and **1262** prevent fluid or other flow from the primary annular area **1221** to the interior of tubular **1224**. In this case first check valve **1258** is between the first gas the valve **1256** and the first gas lift mandrel **1252**. Also depicted is a second gas lift valve **1260**, a second gas lift mandrel **1254**, and a second check valve **1262** between the second gas lift valve **1260** and the second gas lift mandrel **1254**. As depicted the wellbore fluid has risen to the fluid gas interface **1242** but formation pressure is no longer sufficient to push fluid to the surface **1240**.

FIG. **13** depicts the reverse flow gas lift **1250** portion of the hybrid hydraulic gas pump system **1200** in operation. During this initial stage of gas lift the fluid column within the primary annular area **1221** needs to be lightened in order to allow the formation pressure to push the fluid to the surface **1240**. Gas is injected into the primary annular area **1221** as depicted by arrow **1270**. As depicted by arrow **1272** injected gas flows from the tubular **1224** through the first gas lift valve **1256**, through the first check valve **1258**, and into the primary annular area **1221**. The gas then becomes interspersed within the wellbore fluid, usually in the form of bubbles such as bubbles **1263**. With the bubbles **1263** dispersed within the fluid within the primary annular area **1221** the overall density of the fluid within the primary annular area **1221** is reduced allowing the formation pressure to once again push the fluid to the surface **1240**. In certain instances, a single gas lift point such as the first gas lift point provided by first gas lift valve **1256**, first check valve **1258**, and the first gas lift mandrel **1252** is not able to sufficiently reduce the overall density of the wellbore fluid to allow the fluid to be produced to the surface **1240**. Usually, multiple gas lift points are included along the length of the production tubular **1224**. A second gas lift point is depicted as being provided by second gas lift valve **1260**, second check valve **1262**, and second gas lift mandrel **1254**. With respect to the second gas lift point, gas flow, as depicted by arrow **1274**, flows from the tubular **1224** into the second gas lift valve **1260** through the second check valve **1262** and through the second mandrel **1254** where the gas becomes interspersed within the wellbore fluid. While only two gas lift points are shown multiple gas lift points along the length of the tubular may be utilized.

Eventually formation pressure within reservoir **1232** diminishes to the point where the formation pressure is no longer able to push the fluids to the surface even with gas lift reducing the density of the fluid column. It is envisioned that in such an instance a hybrid hydraulic gas pump **1210** may provide the additional pressure necessary to push the fluid column to the surface **1240** in conjunction with the gas lift system **1250**.

FIG. **14** depicts the hybrid hydraulic gas pump system **1200** in a mode of operation where the hybrid hydraulic gas pump **1210**, replacing the pressure provided by the formation **1232**, provides the pressure necessary to push the reduced density fluid to the surface **1240**. In this case the reduced density fluid is being created due to the gas lift system **1250** in operation within the wellbore **1220**. While in certain instances the hybrid hydraulic gas pump **1210** is capable of providing sufficient pressure to force the wellbore fluid to the surface singly, the use of the gas lift system **1250** to reduce the density of the fluid column reduces the overall energy requirements to move the fluids to the surface as the hybrid hydraulic gas pump **1210** requires less pressure to move the reduced density fluids to the surface as compared to moving the same fluid, but without the injected gas to reduce the density of the fluid, the same distance to the surface **1240**. Typically the lowest gas lift point, in this case the gas lift point provided by second gas lift valve **1260**, second check valve **1262**, and second gas lift mandrel **1254**, are placed as close as possible to the hybrid hydraulic gas pump **1210** in order to minimize the amount of full density wellbore fluid between the hybrid hydraulic gas pump **1210** and the second gas lift mandrel **1254**. Any full density fluid within production tubular **1224** between gas lift pump **1210** and second mandrel **1254** increases the weight of the fluid column and thus the pressure required to lift the fluid to the surface **1240** and thus increases the amount of energy required to operate the system. The lower the required pressure, the lower the energy cost to lift the fluid to the surface. Generally, the gas pressure is provided by compressors on the surface.

In the hybrid hydraulic gas pump **1210** mode of operation shown in FIG. **14** the gas supply unit **1230** generally includes a valve that opens during the effective pump cycle and closes during the effective fill cycle. The gas supply unit **1230** may operate independently downhole or may be operated from the surface. The gas supply unit **1230** may operate simply on a timed cycle. The timer may be electrical or mechanical. In some instances, the operation of gas supply unit **1230** is based on sensing the fluid level within the hybrid hydraulic gas pump body **1214**. The fluid level may be sensed electrically such as by sensing resistance of the fluid or may be mechanical such as having a float within hybrid hydraulic gas pump body **1214** to trigger the gas supply unit **1230** open as the hybrid hydraulic gas pump body **1214** reaches the desired fill level and then triggering the gas supply unit **1230** to close as the fluid level within the hybrid hydraulic gas pump body **1214** reaches the second desired fill level although any sensing mechanism may be used. With the gas supply unit **1230** open, pressurized gas from the tubular **1224** flows from the tubular **1224** through the gas supply unit **1230** and into the interior of the hybrid hydraulic gas pump body **1214**. The pressurized gas flowing into the hybrid hydraulic gas pump body **1214** displaces the fluid within the hybrid hydraulic gas pump body from the top down. As the fluid is displaced the first check valve **1216** will close. As additional pressurized gas enters the hybrid hydraulic gas pump body **1214** through the gas supply unit **1230** the fluid within the hybrid hydraulic gas pump body **1214** flows into pickup tube **1218**, through the open second check valve **1222** and into primary annular area **1221** where with the assistance of the gas lift system **1250** the fluid is produced to the surface **1240**. As the hybrid hydraulic gas pump body **1214** is emptied of fluid the gas supply unit **1230** closes in response to the timer, the fluid sensor, or other signal and the cycle is repeated where as depicted in FIG. **13**, the gas supply unit **1230** is shut off and wellbore fluid is allowed to refill the hybrid hydraulic gas pump body **1214** through check valve **1216**.

The nomenclature of leading, trailing, forward, rear, clockwise, counterclockwise, right hand, left hand, upwards, and downwards are meant only to help describe aspects of the tool that interact with other portions of the tool.

Plural instances may be provided for components, operations or structures described herein as a single instance. In general, structures and functionality presented as separate components in the exemplary configurations may be implemented as a combined structure or component. Similarly, structures and functionality presented as a single component may be implemented as separate components. These and other variations, modifications, additions, and improvements may fall within the scope of the inventive subject matter.

What is claimed is:

**1**. An artificial lift system comprising: a production tubular;

a gas lift system having a gas lift mandrel, a gas lift valve; and a first gas supply; and wherein the gas lift system is attached to the production tubular;

a chamber having a first check valve, a second check valve, and is in fluid communication with an intermittent second gas supply line,

wherein the first check valve allows fluid to flow into the chamber through the first check valve while preventing fluid from flowing out of the chamber through the first check valve,

wherein the second check valve allows fluid to flow out of the chamber through the second check valve while preventing fluid from flowing into the chamber through the second check valve;

wherein the chamber is attached to the production tubular; and

wherein the second gas supply line is separate from and positioned within the production tubular.

**2**. The artificial lift system of claim **1** wherein, the first gas supply is provided via a primary annular region.

**3**. The artificial gas lift system of claim **1**, wherein the first gas supply actuates the gas lift system.

**4**. The artificial gas lift system of claim **1**, wherein the first gas supply reduces a density of a wellbore fluid.

**5**. The artificial gas lift system of claim **1**, wherein the second gas supply line strokes the chamber.

**6**. An artificial lift system comprising:

a production tubular;

a gas lift system having a gas lift mandrel, a gas lift valve; and an annular gas supply; and

wherein the gas lift system is attached to the production tubular;

a chamber having a first check valve, a second check valve, and is in fluid communication with the annular gas supply,

wherein the first check valve allows fluid to flow into the chamber through the first check valve while preventing fluid from flowing out of the chamber through the first check valve,

wherein the second check valve allows fluid to flow out of the chamber through the second check valve while preventing fluid from flowing into the chamber through the second check valve;

wherein the chamber is attached to the production tubular;

further comprising a gas supply unit wherein the gas supply unit permits the annular gas supply to stroke actuate the chamber;

wherein the gas supply unit further comprises a fluid level sensor; and

wherein the gas supply unit closes in response to the fluid sensor.

**7**. The artificial lift system of claim **6** wherein, the fluid level sensor is mechanical.

**8**. The artificial lift system of claim **6** wherein, the fluid level sensor is electrical.

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